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ABSTRACT

To help delineate regeneration problems before developing a research program, I conducted a field reconnaissance in 1968 and 1969, of Rocky Mountain Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.) Franco) cutting areas in Forest Service Regions 1 and 4. From file records and field measurements, I obtained information about topography, soils, seedbed, shade, competing vegetation, opening size, habitat type, and history of treatment. Success of Douglas-fir regeneration is presented as percent milacre stocking. Results indicate that the effects of various regeneration methods and the success expected depend largely upon habitat type. Thus, attempts to generalize about seedbed, shade, and other species requirements can be misleading. Results were used to develop a research program for regeneration of Douglas-fir. Problem solutions seemed to center around the need for more careful administration of planting operations and plantation protection and for development of silviculture prescriptions to match species requirements and site potential.

INTRODUCTION

Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco) occurs in mountainous areas throughout the Rocky Mountain States (fig. 1), and the Douglas-fir forest type occupies about 22 percent of the total acreage of commercial forest land. Douglas-fir itself accounts for about 20 percent of the cubic-foot volume and about 23 percent of the board-foot volume on these acres (Wilson and Spencer 1967). In Idaho alone, Douglas-fir is the principal commercial forest type on 4.8 million acres. This is nearly one-third of Idaho's commercial forest land, and 73 percent of these acres are in southern Idaho (Wilson 1962). Montana also has many acres of the Douglas-fir type. Douglas-fir is the major forest type on 11.7 million acres of commercial forest land in Nevada, Utah, Idaho, Montana, and eastern Washington.

Besides the timber values, Douglas-fir forests have major recreation and esthetic values. They are also important watershed cover and grazing lands.

Despite the obvious importance of the species, little research has been conducted to date on stand establishment of Rocky Mountain Douglas-fir in the Intermountain area. There are several reasons for this lack of research. In earlier years, most cutting was done in moist habitats and regeneration was usually adequate. Also, in those days, much cutting left a residual stand; so attention was not focused on any reproduction deficiencies that might have occurred (C. A. Wellner, unpublished report, Forestry Sciences Laboratory, Moscow, Idaho).

In recent years, clearcutting has been the dominant method of harvest. In clearcuts in southern Idaho (south of the Salmon River), central Montana, and on severe sites in western Montana, northern Idaho, and northeastern Washington, Douglas-fir reproduction is usually sparse or absent. Research on Douglas-fir stand establishment has become an urgent need.

In mid-1967, I began studying Douglas-fir stand establishment. Because of the diversity of conditions within the species range and the dearth of previous research on this variety of the species, I made a field reconnaissance to locate problems and to determine the kinds of research needed to solve them. This survey was conducted during the 1968 and 1969 field seasons.

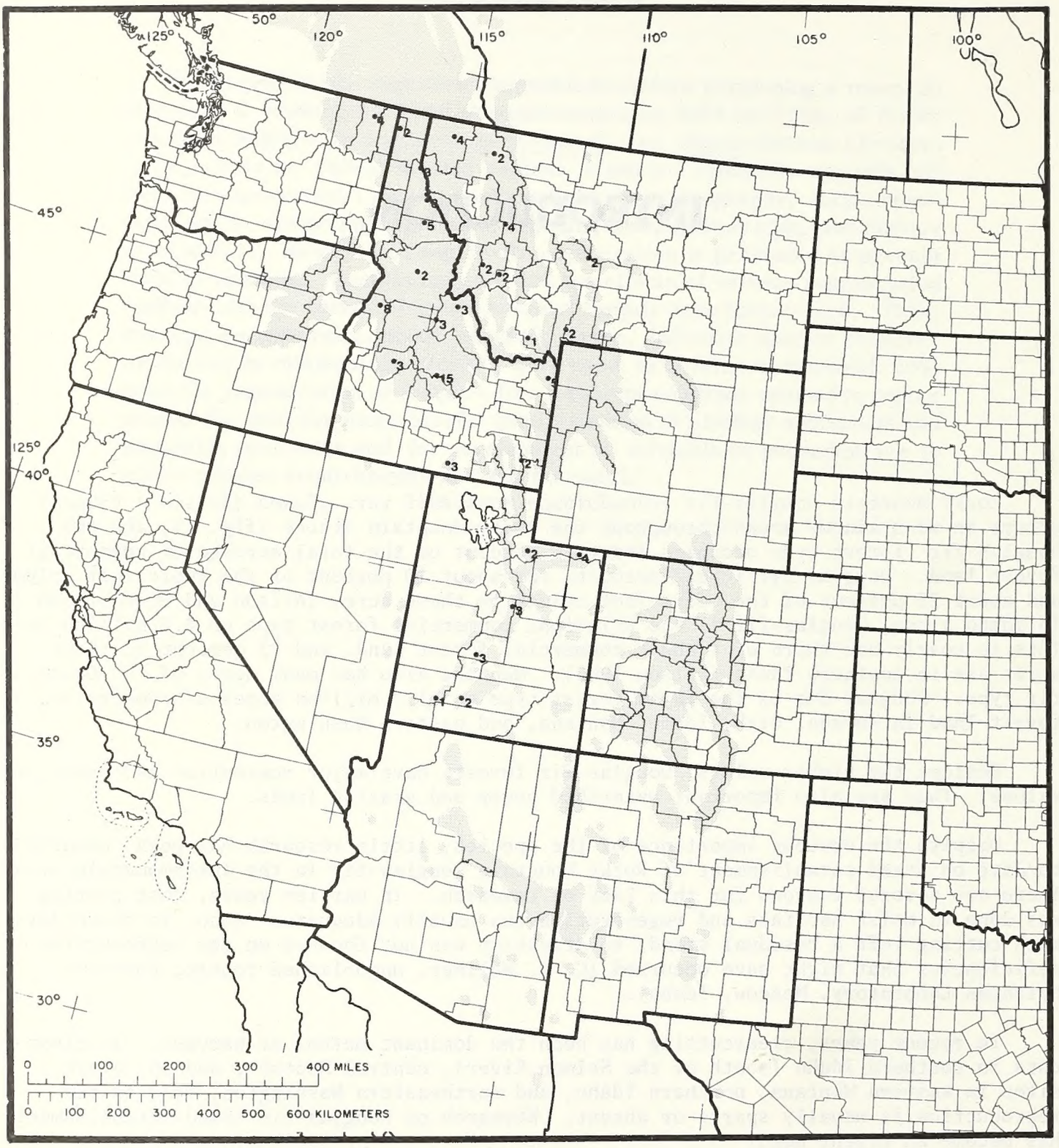

Figure 1.--The range of Rocky Mountain Douglas-fir (from Little 1971). Numerals indicate the number of areas sampled in the general locale of each black dot.

SETTING

Site Conditions

The different and distinct climates that occur within the Intermountain area are due to several factors.

The area extends for 900 miles of latitude and markedly different temperatures are exhibited within this great range.

The north-south orientation of mountain ranges exerts important influences on climate. Areas on the windward side receive greater amounts of precipitation than areas on the leeward side. Mean annual temperature decreases about 3° F for each 1,000-foot rise in elevation. Other factors, such as wind, humidity, cloudiness, and radiation, are similarly modified by the topography.

In northern Idaho and northwestern Montana, a strong maritime influence penetrates to the Continental Divide. The long, wet winters and comparatively short summer drought period of this area are more favorable for tree establishment than are climatic conditions throughout the remainder of the study area.

The country east of the Continental Divide gets frequent cold and dry air masses from Canada during the winter and persistent warm southerly winds from Mexico and the Gulf of Mexico in the summer.

The pattern of climates throughout the Intermountain area (U.S. Department Commerce 1968) suggests that, in general, conditions are probably most favorable for tree establishment in northern Idaho and northwestern Montana, becoming progressively less favorable farther south and abruptly less favorable east of the Continental Divide.

The diversity of climates is accompanied by an equally impressive diversity of geology and soils. Major portions of the area are represented by uplifted sedimentary formations and by volcanic, granitic, and basaltic formations. Soils range from highly erodible to quite stable, from nutrient rich to somewhat nutrient deficient and from droughty to moist. When combined with environmental differences fostered by geographic position and varied topography, soil diversity creates a complex pattern of site conditions.

Figure 2.--In this western hemlock habitat in northern Idaho, Douglas-fir is a relatively short-lived seral tree. It establishes more readily in exposed situations (clearcuts) here than it does in other habitats, but later growth is hindered by competition from better adapted species.

Species Behavior

Within a range extending more than 2,000 miles from north to south, Rocky Mountain Douglas-fir grows in widely diverse environments (fig. 2-6). Environmental variety has led to physiological and ecological diversity within the species.

Frothingham (1909) suggested that, under moist conditions, Douglas-fir reproduces better in the open than under drier conditions where it requires some protection by other species, which it eventually replaces. Krajina (1965) recognized this for Douglas-fir in Canada. Krauch (1956), working in the southern Rockies, found that shade favored seedling establishment and early growth. In ecological terms, Douglas-fir is a seral species on moister sites and a climax species on somewhat drier sites.

The Daubenmires (1968) classified the forest vegetation of eastern Washington and northern Idaho into 22 habitat types, which they considered to be ". . .the basic ecologic subdivisions of landscapes." Each habitat type has a distinct potential as to sere and climax, and is recognized by a distinctive combination of overstory and understory at maturity. Three of these habitat types have Douglas-fir as the major climax species. In five other more moist habitat types, it is a seral species.

In central Idaho, preliminary forest habitat type work indicates that Douglas-fir grows in 29 habitat types. It is a climax species in 14, a major seral species in 10, and a seral species in certain parts of the range of the other 5 habitat types.

Before we can confidently predict how Douglas-fir will respond to different treatments, especially in the regeneration portion of the life cycle, we must first identify differences in site conditions and then determine how the species responds to each particular set of conditions. Results of my field reconnaissance emphasize this point.

Figure 3.--In this western redcedar habitat, Douglas-fir is long lived. Partial shade seems to benefit the growth of young trees.

Figure 4.--Douglas-fir regeneration under a larch--ponderosa pine--Douglas-fir overstory on a Douglas-fir habitat. The young trees benefit from protection of surrounding trees.

Figure 5.--These stands in south-central Idaho are composed almost entirely of Douglas-fir and lodgepole pine. Regeneration of Douglas-fir on these habitats is much more difficult than on those depicted in figures 2-4.

Figure 6.--In the high plateau country of southern Utah, Douglas-fir is often a major component of the overstory, but is only a minor component of the understory, which is dominated by subalpine fir and Engelmann spruce. When the photo was taken (1968) there were still no tree seedlings in this 3-year-old opening.

OBJECTIVES

To delineate Douglas-fir regeneration problems, a field survey was conducted to identify and superficially characterize the factors of environment most closely associated with the establishment of new stands of Rocky Mountain Douglas-fir. More specifically, the objectives were: (1) to describe the problem effectively and (2) to furnish leads and direction for planning a study program.

The data obtained in this survey depict only the relative degree of success of Douglas-fir under different site conditions. They should not be construed to be a precise measure of the success of the overall stand-regeneration program of any National Forest or of Region 1 or 4. For instance, I did not attempt to evaluate the success of other species, and many Douglas-fir plantations in northern Idaho and northwestern Montana had other species seeding in and regenerating the areas. Also, some areas were planted with a mixture of species, including Douglas-fir. These areas were not sampled because of the futility of determining the number and planting location of trees of each species--rarely are they planted in uniform patterns over an entire cutting area. To get a good estimate of overall success, I would have needed a representative sample of all Douglas-fir cutting areas. The sample was restricted so as to get as wide a range of site conditions as possible within alloted time and resources.

METHODS

My field survey was limited to areas that had been cut within the past 15 years. In all, I sampled 95 cutting areas in 26 National Forests, 12 in Region 4, and 14 in Region 1 (fig. 1 and appendix I). Though I attempted to sample areas in different silviculture systems, most were clearcuts.

On each cutting area, I sampled Douglas-fir reproduction along two transects on each major aspect. These transects ran from the downslope timber edge to the top edge of the openings. Along each transect, I attempted to locate 10 circular milacre plots at approximately equal intervals, beginning under the canopy at one edge and ending under the canopy at the other edge. Sometimes I took more than 10 plots. If my estimate of the distance across the opening was short, I continued to take plots at equal distances until I reached the stand edge. If the opening was small, I took fewer plots per transect because minimum spacing between plots was one-half chain.

Data are presented in terms of milacre stocking computed by dividing the number of plots with one or more trees by the total number of plots sampled.

From file records and field measurements, I obtained information about the topography, soils, seedbed, shade, competing vegetation, habitat type, distance from timber edge, and history of each area since cutting.

I used the Daubenmires' key (1968) to name habitat types throughout northern Idaho and eastern Washington. Where a habitat classification system was not yet developed, I used the tree species that appeared to be climax to identify the habitat of our cutting areas and made no attempt to subdivide further on the basis of understory vegetation. Accordingly, data from all areas are summarized primarily by climax tree species, which are used to approximate the Daubenmires' habitat type series.

RESULTS

Because the northern part of the study area has a larger proportion of its forested areas in moist environments than does the south, I expected success of stand regeneration to decrease from north to south. Survey data show this to be generally the case. The percent of stocked milacre plots in our sampled areas decreased from about 26 in the north to 10 in the south for plantations and from about 47 to 20 percent on areas where natural regeneration was the goal.

Of even more interest than the geographical relationship was the apparent correspondence between habitat type and regeneration success. As I was sampling an area on the Payette National Forest about midway through the survey, my transects crossed a narrow ecotone between a subalpine fir (*Abies lasiocarpa*) type and a grand fir (*Abies grandis*) type. A Douglas-fir plantation was established and growing on the subalpine fir site, but on the grand fir site Douglas-fir survival was near zero. This same phenomenon was observed in other areas.

It became obvious that summarizing data for other factors without regard to habitat type could be misleading. I lacked a habitat type classification system for most of the area and compromised by ignoring understory vegetation and using the climax tree species to classify the habitat of each plot.

When summarized in this manner, the data in table 1 suggest that (1) greater stocking of natural Douglas-fir seedlings occur on the western hemlock habitat than on other habitats, and (2) Douglas-fir plantation success on the western redcedar and western hemlock habitats approximately doubles that of warmer and drier habitats. We sampled few direct-seeded areas, but those sampled had results similar to those of naturally seeded plots.

Table 1.--*One-milacre plot stocking of Douglas-fir by habitat (climax tree species) and geographic area*

Climax tree species[a]	Geographic area[b]	Planting		Natural seeding		Direct seeding	
		Number of plots	Percent stocked	Number of plots	Percent stocked	Number of plots	Percent stocked
Douglas-fir	1	110	20	47	47	33	42
	2	0	--	80	24	0	--
	3	435	19	84	38	69	17
	4	0	--	61	39	0	--
	Mean		19		36		25
Grand fir	1	68	18	0	--	0	--
	3	86	9	52	8	31	6
	Mean		13		8		6
Western redcedar	1	123	31	0	--	0	--
Western hemlock	1	97	37	35	69	0	--
Mountain hemlock	1	63	17	0	--	0	--
Subalpine fir	1	35	26	22	14	45	27
	2	78	14	0	--	0	--
	3	125	22	20	5	0	--
	4	205	10	63	2	0	--
	Mean		15		5		27

[a]At the time of the survey, habitat types had not been described for the area outside of northern Idaho. The data are summarized by climax tree species:

Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco
Grand fir, *Abies grandis* (Dougl.) Lindl.
Western redcedar, *Thuja plicata* Donn.
Western hemlock, *Tsuga heterophylla* (Raf.) Sarg.
Mountain hemlock, *Tsuga mertensiana* (Bong.) Carr.
Subalpine fir, *Abies lasiocarpa* (Hook.) Nutt.

[b]The study area was divided into four geographic areas:

Geographic area	*National Forests sampled*
1--Northern Idaho and western Montana	Clearwater, Coeur d'Alene, Colville, Flathead, Kaniksu Kootenai, Lolo, Nezperce, and St. Joe.
2--Central Montana and eastern Idaho	Caribou, Gallatin, and Lewis and Clark
3--Southwestern Montana and central Idaho	Beaverhead, Bitterroot, Boise, Challis, Deerlodge, Payette, Salmon, and Sawtooth
4--Utah	Ashley, Cache, Dixie, Fishlake, Manti-LaSal, and Wasatch

Stocking sometimes varies for habitats with the same climax species when they are located in different geographic areas. For instance, on subalpine fir habitats in areas 1 and 3 (table 1), plantation stocking is nearly double that on subalpine fir habitats in areas 2 and 4. Stocking also varied for grand fir habitats; area 1 had twice the stocking of planted trees as area 3. Much of this diversity might have been explained by different habitat types if a classification system had been available that used understory vegetation criteria to further subdivide the range in environmental conditions for all areas.

The only data I have for habitat types common to more than one geographic area are tabulated below, for planted trees only:

Habitat type	*Area 1*	*Area 3*
	(Percent stocking)	
Pseudotsuga menziesii/Physocarpus malvaceus (Douglas-fir/ninebark)	0	20
Pseudotsuga menziesii/Calamagrostis rubescens (Douglas-fir/pinegrass)	20	23
Abies lasiocarpa/Menziesia ferruginea (Subalpine fir/menziesia)	40	44

From this meager data, it appears that Douglas-fir plantation success may be comparable for the same habitat type in different geographic areas.

Seedbed.--On all habitats for which I have enough data for comparison, plantation stocking was higher on plots bared to mineral soil than on plots with litter on the soil surface (fig. 7). It is not clear why I found fewer planted trees where litter was present. Perhaps trees generally were not planted except where mineral soil was exposed by thorough site preparation, or perhaps debris was carelessly put into planting holes and contributed to high mortality. Also, competition might have been less rigorous on plots with bare mineral soil.

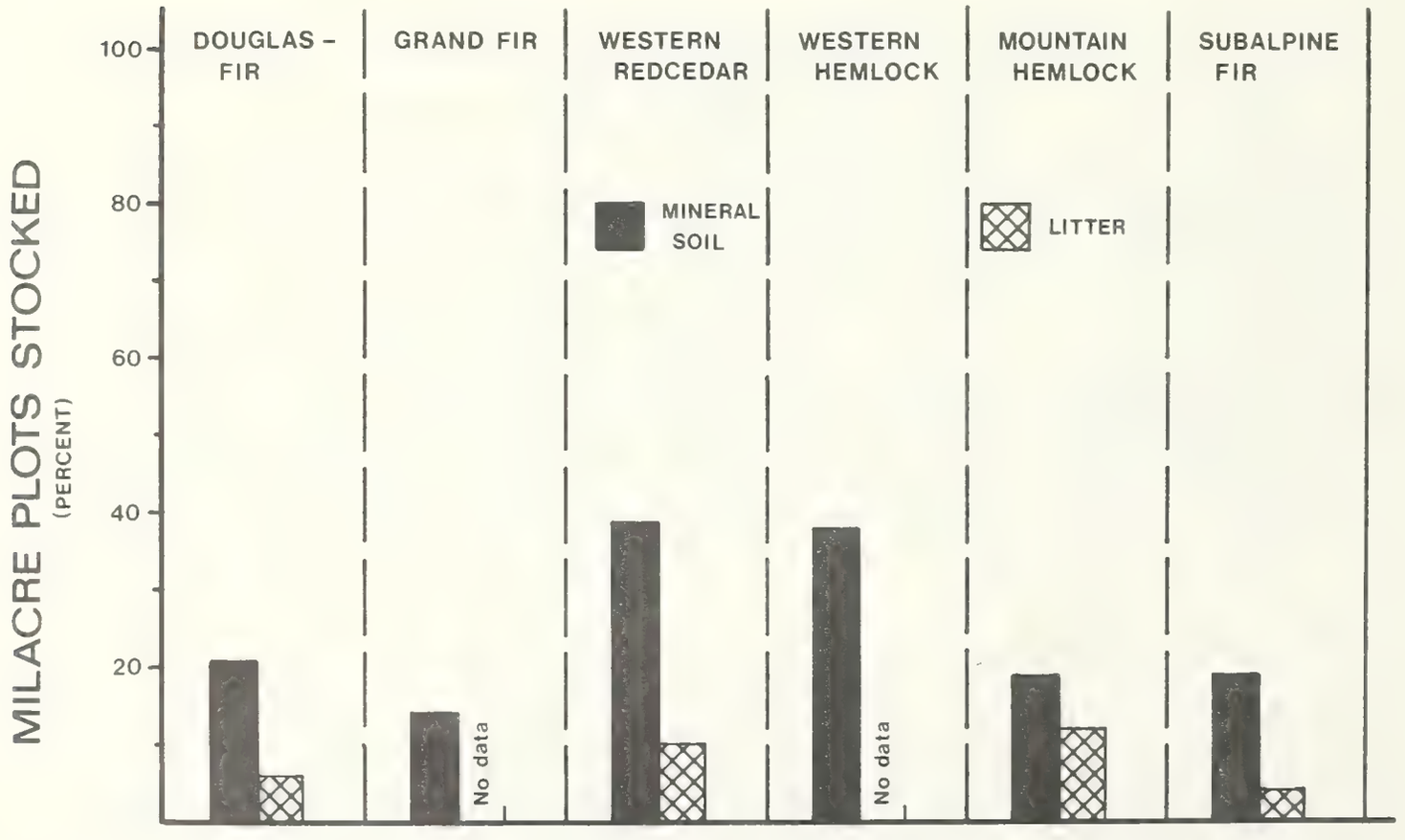

Figure 7.--Stocking of planted Douglas-fir expressed as percent of 1-milacre plots sampled. Success was better on bared soil surfaces on all habitats for which data were available.

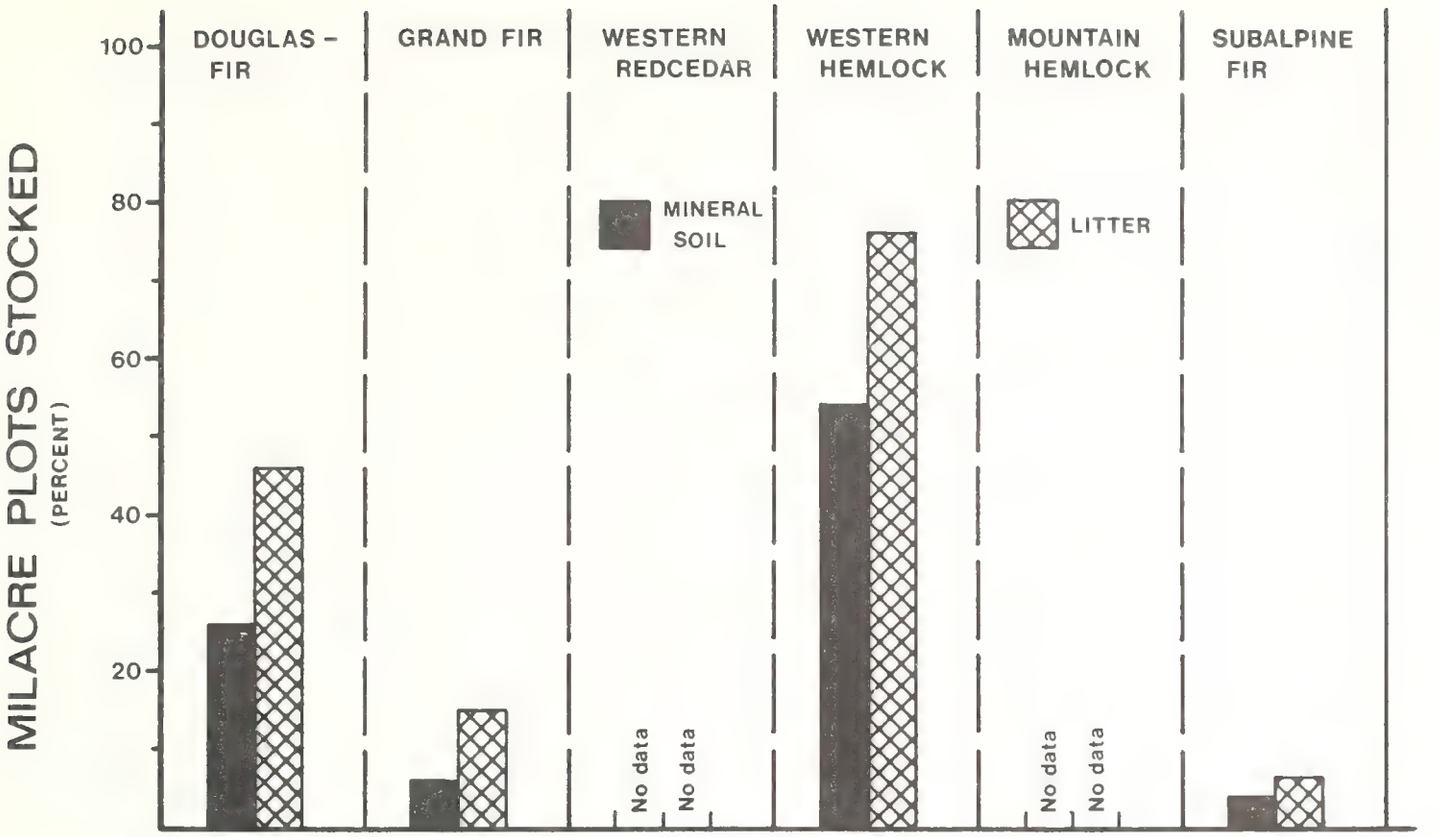

Figure 8.--Stocking of naturally seeded Douglas-fir expressed as percent of 1-milacre plots sampled. Success was better on litter-covered seedbeds on all habitats for which data were available.

Litter does not prohibit establishment of natural seedlings of Rocky Mountain Douglas-fir. In fact, I found a greater percent of litter-covered plots stocked than plots with exposed mineral soil (fig. 8). Hatch and Lotan (1969) reported similar findings in central Montana. Schmidt (1969) working in northwestern Montana found Douglas-fir less sensitive to seedbed conditions than western larch insofar as both seedling establishment and growth were concerned. Contrary to this, Shearer and Schmidt (1970) found more ponderosa pine and Douglas-fir seedlings on scarified plots than on undisturbed plots in western Montana. In my survey and in the study by Hatch and Lotan, some bare areas were created by logging disturbance. Others may have been caused by such disturbances as animal trampling, which may have caused seedling mortality. However, studies reported by Schmidt and by Shearer and Schmidt had definite site preparation treatments; other disturbances were held to a minimum.

When other environmental factors are equal, Douglas-fir will probably perform better in mineral soil than in litter. However, the preparation of a mineral soil seedbed does not seem to be as critical for Douglas-fir on some habitats as for other species, such as western larch. Further research is needed before seedbed requirements are known for the various habitats in which Douglas-fir grows.

Depth of organic matter.--The depth of organic matter on any relatively undisturbed forest site probably depends to a large extent on the habitat type of the site. Though I recorded the habitat of each plot, there were not enough data in each depth category to obtain dependable averages until I combined habitats. Therefore, organic matter data are confounded with habitat effects and are even more difficult to interpret than seedbed data.

I found natural seedlings of Douglas-fir established on plots with organic matter ranging in depth from 0 to 2 inches, but the greatest stocking was on plots with about 1-3/4 inches of organic matter. Stocking (1-milacre) of natural Douglas-fir seedlings by depth of organic matter was as follows:

Depth		*Stocking*
(Inches)	*(Centimeters)*	*(Percent)*
0	0	30
1/2	1.3	33
3/4	1.9	41
1	2.5	50
1-1/4	3.2	48
1-1/2	3.8	68
1-3/4	4.4	72
2	5.1	64

However, about all that can be said at this point is (1) that Douglas-fir can become established through organic material on the surface, and (2) we need to study the microsuccession of the forest floor of various habitat types before offering an explanation of how organic matter affects young Douglas-fir seedlings.

Vegetational competition.--Because there were so many gaps in the data for natural seeding, my comparisons between levels of competition are based on planted-tree data only. On habitats where the greatest stocking is typically found, heavy competition appears to have reduced stocking (fig. 9), but on more severe sites I found about the

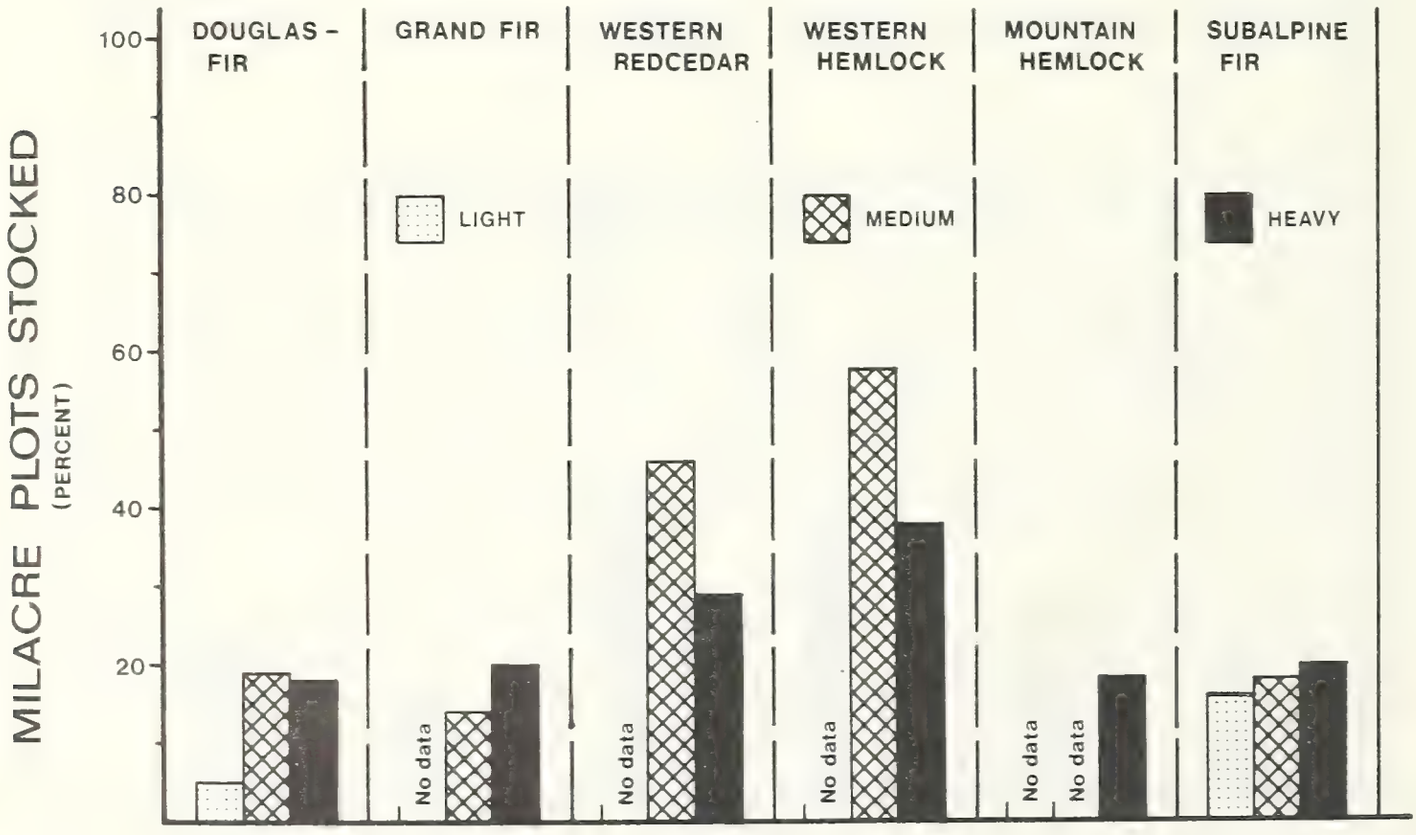

Figure 9.--On the western redcedar and western hemlock habitats, heavy competition appears to have reduced stocking. On more severe sites, as many or more trees were found where competition was greatest.

same number of trees, regardless of competition. We apparently need to strike a balance between vegetation left for protection against sun and wind, and vegetation removed to increase available water, light, and nutrients. This balance point is expected to differ with habitat and amount of logging debris left on the site.

Shade.--An important factor affecting survival of young Douglas-fir trees is the portion of daylight hours during which a tree is shaded. Only on western hemlock habitats were more trees found out in the open than where they received shade during part of the day (fig. 10). On all other habitats, more Douglas-fir trees were found under partial shade.

Shade was often from the surrounding stand, but not always. Sometimes logging debris, shrubs, and forbs offered protection, especially in clearcuts where debris had not been piled and burned.

The major benefit from shade is believed to be the amelioration of temperature and moisture extremes. The intensity of the light itself does not appear to limit the growth of trees in this area.

Distance from stand edge.--Most natural seedlings of Douglas-fir were found within 1 chain of the stand edge on Douglas-fir habitats. Milacre stocking decreased from 57 percent close to the stand edge to 9 percent at 4 chains or more into the opening. However, proximity to stand edge was not necessary for seedling establishment on moister habitats. For instance, milacre stocking on the western hemlock habitat averaged 65 percent close to the stand edge, but increased to 77 percent at distances of 1 to 3 chains from the edge. Larger openings relying on natural regeneration were not found in this habitat.

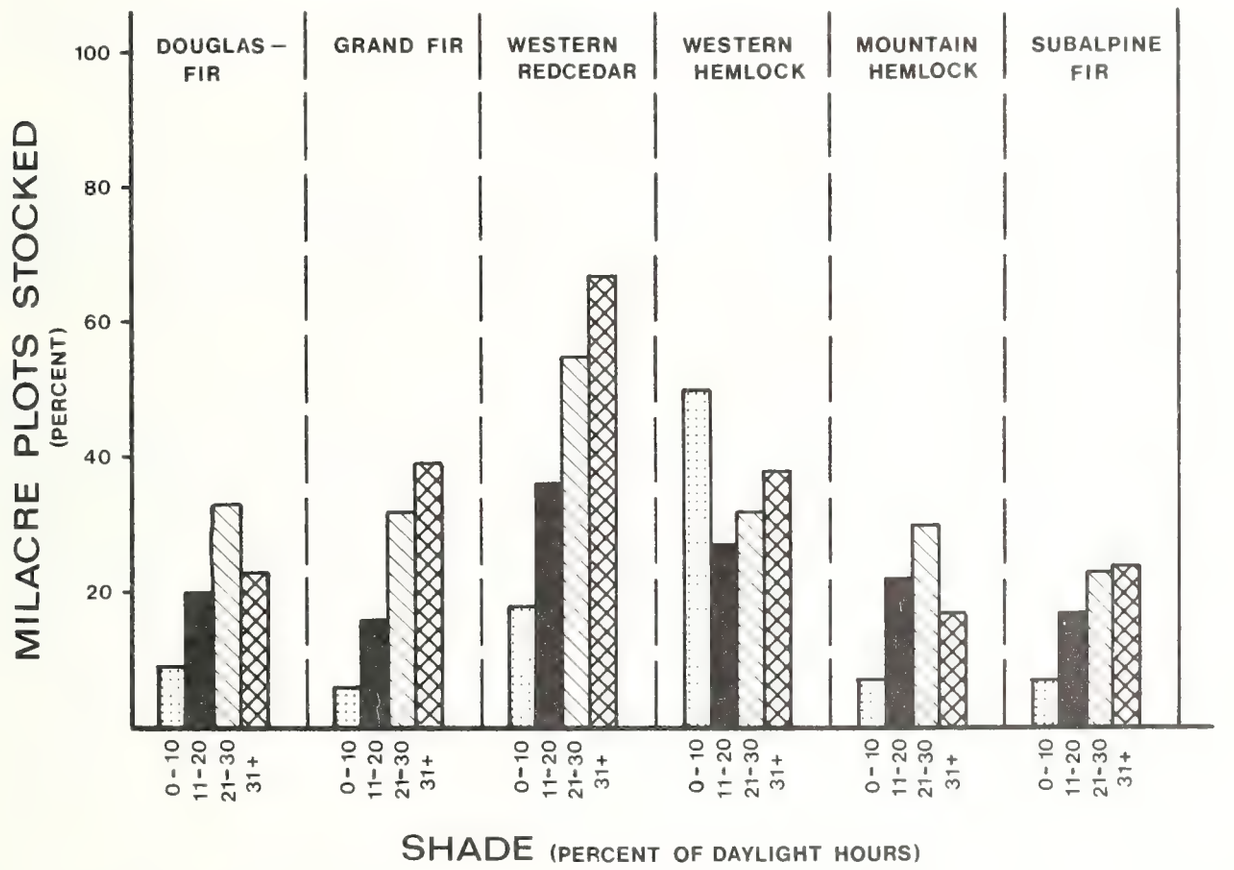

Figure 10.--More planted Douglas-fir trees survived on the western hemlock habitat when they received direct sunlight throughout the day. On the other habitats, shade during some portion of the day seemed to increase survival.

Seed dispersal patterns and differences in environment contribute to differences in effect of distance from stand edge on seedling establishment. Boe (1953) found the quantity of sound Douglas-fir seed that fell to the ground decreased rapidly from timber edge to about 4 chains. R. C. Shearer (personal communication, research silviculturist, Missoula, Mont.) has found the number of sound seeds required per established tree to differ greatly with changes in habitat. Therefore, on the drier sites the amount of seed reaching the middle of larger openings may not be sufficient for successful regeneration.

DISCUSSION

The intention of this survey was to determine where Douglas-fir regeneration problems exist. Admittedly, the results from a quick survey of this type are not conclusive and have a lot of holes. For instance, certain conditions were encountered so seldom in my sample that data are scarce or completely lacking for some categories in the summarization tables. Also, our comparisons of planting success on the basis of percent milacre stocking assumes that approximately the same number of trees were planted per acre on all habitats. It also assumes that handling and planting techniques and quality of nursery stock were generally comparable throughout the study area. It is probable that these assumptions have not been met in all cases.

Nevertheless, I am confident the data are sufficient for the stated purpose. They show us that the success of Douglas-fir regeneration varies with habitat, and that success has been low on sites where Douglas-fir attains climax status. In view of the great diversity of plantation success and of Douglas-fir sites in the Northern Rockies, this seems to be a logical conclusion. It also agrees generally with the results of previous work.

While studying factors affecting regeneration of western Montana clearcuts, Steele and Pierce (1968) observed that where wildfires have burned over large areas, south aspects are extremely slow to regenerate. They concluded that the south and west exposures need special consideration in determining the cutting method to be employed as well as in the treatment of the resulting slash. Larsen (1924) also points out the difficulty of obtaining regeneration on south aspects due to extremes in temperature and drought. These south-aspect sites are often Douglas-fir habitat types.

Boyd (1969) described natural regeneration trends in some northern Idaho western white pine stands. On moist habitats, even-aged silviculture systems resulted in adequate regeneration within 5 to 10 years. Drier habitats had a prolonged regeneration period, possibly exceeding 20 years, regardless of the silviculture system used. His dry sites were grand fir habitats, which are more moist than the Douglas-fir habitats.

Results from a recent planting study (manuscript in preparation) also confirm the effect of habitat on plantation success. In a planting test of species adaptation to high-elevation clearcuts, first-year survival was high (90 to 100 percent) on most plots regardless of habitat. By the end of the third year, however, survival was related to habitat types.

Failure to develop silviculture prescriptions compatible with ecological considerations was not the sole reason for generally low success of Douglas-fir plantations over the 15 years prior to 1968. Browsing and trampling by domestic livestock caused immense damage in many plantations. Low vigor of planting stock from the nursery was often suspected. This may have been caused by cultural practices in the nursery, or by lifting, handling, and storage procedures that did not adequately maintain tree vigor until planting time. The planting procedure was also suspect. A poor selection of planting spot, improper placement of roots, improper planting depth, and air pockets and debris in the planting hole undoubtedly have reduced survival and growth of planted trees. In the Intermountain region, Douglas-fir seems to be more sensitive than other species to mishandling. Therefore, it is imperative that all procedures be carefully performed.

For natural seeding, one or more of a number of factors may have contributed to a lack of regeneraton on any specific area. The budworm (*Choristoneura occidentalis* Freeman) was widespread in Montana and Idaho during the 15-year regeneration period studied. Dewey (1970) found it to be a serious pest to Douglas-fir cones. Squirrels and ground-dwelling rodents can seriously reduce the number of seeds available at germination time (Shearer and Schmidt 1970). Dwarf mistletoe, bark beetles, and root rot are other agents that reduce the vigor of Douglas-fir trees. The extent of damage from these agents is probably related in some degree to habitat type.

RECOMMENDATIONS

An accurate description of site potential is needed where research is done. A similar site evaluation must be made by the land manager using research results to prescribe silviculture treatments for a specific unit of land. Both evaluations appear to be indispensable to consistent success in Rocky Mountain Douglas-fir regeneration efforts.

Douglas-fir is important over a wide range of habitat conditions. Consequently, successful regeneration of individual stands will require knowledgeable use of different cutting systems, selection of applicable site preparation and artificial regeneration measures, and careful execution of each step of the selected treatments. What can be done with success on some sites may not succeed on others (appendix II).

The most logical approach for our research program would be to (1) develop a habitat type classification for the remaining forest lands in the five-State area sampled, (2) determine the requirements of the species, and (3) evaluate effects of different silvicultural systems and develop guidelines for regenerating stands on major habitat types that support Douglas-fir.

In the meantime, the land manager should give careful attention to all phases of each operation. For instance, in plantation establishment, he should make sure that seed is from good trees adapted to the planting site; that nursery practices produce vigorous planting stock; that stock vigor is maintained by careful lifting, handling, and storage; and that planting is carefully done. Though handling and planting requirements to maintain tree vigor are adequately known, further refinements, such as requirements for each species, will pay dividends. But, too often the big stumbling block is getting the job on the ground done in strict accordance with the prescription.

Recent cooperative efforts between the Lucky Peak Nursery, National Forest Administration, and Intermountain Forest and Range Experiment Station have resulted in substantial improvement in the vigor and quality of planting stock produced, and in the care and methods used for shipping, storing, and planting trees in Region 4. These efforts have raised the level of first-year survival for all species planted in the last 2 years. For Douglas-fir, this careful attention to every detail is absolutely necessary for reasonable success even on the better Douglas-fir sites.

Habitat type classification efforts are also underway in central Idaho and Montana. Preliminary classifications have been developed and tested, and publications presenting classification systems for Montana and central Idaho are being prepared. Parts of southern Idaho and Utah still need considerable fieldwork before a system can be developed for those areas.

We must now determine the requirements of Douglas-fir from different geographic areas and different habitats. This work has been initiated by Rehfeldt (1974a, 1974b) in northern Idaho and western Montana, but needs to be expanded to cover the rest of the Intermountain area.

We must also begin to develop silviculture prescriptions for major habitat types. When accompanied by careful attention to operational details, silviculture prescriptions aimed at fitting the capabilities of the site to the requirements of the species should attain a high degree of consistency in regeneration of Douglas-fir.

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APPENDIX I

Number of areas sampled by National Forests and Regions 1 and 4 (R-1 and R-4)

Region	Forest	Areas sampled (number)
Northern (R-1)	Beaverhead	1
	Bitterroot	2
	Clearwater	5
	Coeur d'Alene	3
	Colville	4
	Deerlodge	2
	Flathead	2
	Gallatin	2
	Kaniksu	2
	Kootenai	4
	Lewis & Clark	2
	Lolo	4
	Nezperce	2
	St. Joe	3
Intermountain (R-4)	Ashley	4
	Boise	3
	Cache	2
	Caribou	5
	Challis	3
	Dixie	3
	Fishlake	3
	Manti-LaSal	3
	Payette	8
	Salmon	3
	Sawtooth	18
	Wasatch	2
		95

APPENDIX II

Percent stocking of Douglas-fir (1-milacre quadrats) by seedbed type, silviculture system, and habitat (climax tree)

Climax tree species	Silvicultural system	Regeneration method	Seedbed type				
			Mineral	Litter	Ash	Moss	Muck
Douglas-fir	Clearcut	Planting	22	8	[1]14	--	--
		Natural seeding	16	9	--	--	--
		Direct seeding	32	--	--	--	--
	Strip cut	Planting	18	0	8	--	--
		Natural seeding	60	86	--	--	--
		Direct seeding	--	--	--	--	--
	Group selection	Planting	21	[1]17	--	--	--
		Natural seeding	36	58	--	--	--
		Direct seeding	[1] 0	0	--	--	--
Grand fir	Clearcut	Planting	14	[1] 0	--	--	--
		Direct seeding	6	--	--	--	--
	Seed tree	Natural seeding	6	15	[1] 0	--	--
Western redcedar	Clearcut	Planting	39	10	[1]11	[1] 0	[1] 0
Western hemlock	Clearcut	Planting	42	--	--	--	--
	Group selection	Natural seeding	[1]33	92	--	--	--
	Strip cut	Natural seeding	60	56	--	--	--
Mountain hemlock	Clearcut	Planting	19	12	--	--	--
Subalpine fir	Clearcut	Planting	20	5	20	6	--
		Natural seeding	5	10	--	--	--
		Direct seeding	29	[1]14	--	--	--
	Group selection	Natural seeding	0	6	--	--	--
		Planting	9	0	--	--	--

[1] Based on fewer than 10 plots.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1975 — 677-328 / 24 REGION NO. 8

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1975. A survey of factors affecting regeneration of Rocky Mountain Douglas-fir. USDA For. Serv. Res. Pap. INT-174, 19 p. (18 refs.) Intermountain Forest & Range Experiment Station, Ogden, Utah 84401.

Results of a field reconnaissance to locate problems relative to stand establishment of Rocky Mountain Douglas-fir in the Intermountain area indicate that the effects of various regeneration methods and the success expected depend largely on habitat type. Results were used to develop a research program for regeneration of Douglas-fir.

OXFORD: 236.4: 614.
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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field programs and research work units are maintained in:

Billings, Montana
Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho)
Provo, Utah (in cooperation with Brigham Young University)
Reno, Nevada (in cooperation with the University of Nevada)

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

GROWING FROM '76

U.S. FORESTRY CENTENNIAL